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Biofuels: Need of the hour

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The Earth is passing through a very difficult phase of global warming with the CO_2 levels having shot up from 280ppm in 1960 to more than 400ppm now (Dangerous Levels Beyond 450ppm). In ice age it was 180ppm. The temperature risen by more than 1.4°C (0.8°C) leading to problems related to Tsunami, floods, melting glaciers and erratic seasons. Anthropogenic emissions contribute to global warming by burning fossil fuels such as coal, petroleum diesel and above all deforestation in the name of development, for forests are great carbon sinks. We have reached a stage where the use of fossil fuels are totally stopped and renewable fuels such as Bio-fuels such as Bio-Diesel and Bio–Ethanol which are" solar liquids" are promoted and are the need of the hour. They are going to play an extremely important role in addressing global warming concerns associated with petroleum fuels. But also in meeting India's energy needs, which are expected to grow at 4.8% over the next couple of decades, and will address energy security as we presently import 75% of the total crude costing 7lac-crore/year and also. Brazil has made a turnabout in the economy by using Ethanol as a substitute to gasoline while India has missed the race. Diesel is highly polluting and carcinogenic and its demand is five times petrol. So it's very pertinent that it be replaced. Ethanol and biodiesel are gaining worldwide acceptance as biofuels, ethanol in spark-ignition engines and bio-diesel in compression-ignition engine vehicles which up to 15-20% blending need no change in engine. Other fuels are dimethyl ether (DME) or blends with diesel for buses trucks as clean fluids by Volvos in Japan, Europe, USA and Fischer-Tropsch liquids (FTL) made from coal used in South Africa as diesel. Nitin Gadkari, Transport Minister says blending of Bioethanol will go up to 22.5% and of bio-diesel up to 15%. As ethanol produced from molasses is not sufficient to meet the blending even up to 10%. Thus, the second generation fuel from the lignocellulosic biomass like bagasse wood etc needs to be tapped. In our laboratory both Bio-Ethanol and Bio-Diesel are being synthesized. Bio-Ethanol has been produced from Corn Cob and Bio-Diesel by the effect of Oleaginous microorganisms including bacteria, mold, yeast, microalgae effect on Bagasse to produce lipids and their further transesterification to produce Bio-Diesel. For Ethanol the bioconversion was carried out using a hybrid approach for co-utilization of dilute acid hydrolysate (pentose rich stream) and hexose rich stream obtained by enzymatic saccharification employing commercial Cellic–$Ctec_2$ as well as in-house cellulase preparations derived from *Malbranchea cinnamomea, Scytalidium thermophilium* and a recombinant *Aspergillus* strain. For Ethanol, Acid hydrolysis (1% H_2SO_4) of corncob at 1:15 solid-liquid ratio led to removal of 80.5% of hemicellulosic fraction. The solid glucan rich fraction (63.5% glucan, 8.3% pentosans and 27.9% lignin) was hydrolyzed at 10% substrate loading rate with different enzymes for 72 h at 50°C resulting in release of 732 and 535 (mg/g substrate) total sugars by Cellic-$CTec_2$ and *M. cinnamomea* derived enzymes, respectively. The fermentation of enzyme hydrolysate with co-culture of *Saccharomyces cerevisiae* and *Pichia stipitis* added in sequential manner resulted in 3.42 and 2.50% (v/v) ethanol in hydrolysate obtained from commercial Cellic-$CTec_2$ and *M. cinnamomea*, respectively. Employing a hybrid approach, where dilute acid hydrolysate stream was added to solid residue along with enzyme Cellic-CTec2 during staggered simultaneous saccharification and fermentation at substrate loading rate of 15% resulted in 252g ethanol/kg corncob. By this method glucose produced was immediately fermented and less inhibitors were produced making the process more efficient and quick. The studies have been monitored by SEM, TEM, XRD, and FTIR to corroborate the results. Bio-diesel is monoalkyl esters of vegetable oils such as canola (rapeseed), cotton seed, palm, peanut, soybean and sunflower oils. Rapeseed and sunflower oils are predominantly used in Europe while palm oil predominates in Tropical countries. Oleaginous microorganisms including bacteria, mold, yeast, microalgae are considered promising candidates as they are not affected by seasons, high lipid contents and can be produced from a full diversity of carbon sources to give a similarity of fatty composition to that of vegetable oils. They can achieve high cell density on a variety of low cost materials such as industrial sugars, agricultural waste and raw glycerol generated as bio-diesel waste. Bio-Diesel has been produced from Oleaginous yeast *Trichosporon* sps. yeast strain which has been isolated from decayed wood. Its potential to produce lipids has been evaluated on glucose, glycerol and sugarcane bagasse acid hydrolysate. The fermentation process was carried out for 120h at 30°C. Lipids were extracted and subjected to transesterification using acidic Methanol (1% H_2SO_4). The mixture was heated at 60°C for 12h at alcohol/oil ratio of 6:1 and top phase containing fatty

acid methyl esters (FAME) analysis of lipids was carried out by GC-FID and NMR. It revealed the presence of Oleic acid, Palmitic acid, Linoleic acid and Stearic acid. The Biodiesel properties (Iodine Number, Cetane Number, and cold filter plugging point) showed the sustainability of the yeast strain with potential for Biodiesel production. The cetane number of the lipids ranged from 53.39 to 59.59 indicating stability of Bio-diesel production. Sugarcane bagasse is one of the important lingo-cellulosic agricultural by-products which upon acid hydrolysis (1% H_2SO_4 with a solid-liquid ratio of 1:15 in an autoclave for 30 mins) results in the xylose-rich stream. This can be utilized for the biosynthesis of lipids. The possibility of using the biodiesel derived waste, glycerol and acid hydrolysate of agriculture waste for cultivation of yeast culture will simultaneously provide a method for the disposal of large volumes of algae biodiesel derived waste. India is a very diverse country with rich dense forests of the North-East. Attempts are being made for the production of Bio-Ethanol from Bamboo.

Biography

Satindar Kaur completed her PhD in Chemistry from Guru Nanak Dev University, Amritsar (India). Was later on appointed as Professor and Head Department of Sugar and Alcohol Technology. She has more than 80 publications in international journals. For one of the student's PhD thesis has been published in LAMBERT Publications. Has one patent to her credit and a life member of International Sugar Organization (ISO) and ISSCT having presented papers in ISSCT international conferences. Was appointed as a referee in ICUMSA for plantation white sugar for GS-9 and S-6. Attended the ICUMSA meet as a referee at the University of Cambridge in 2012. Has been working in the field of biomass conversion with one PhD student presently working on Thermochemical and biochemical methods using hybrid methods with developed and new strains in the laboratory for quick and efficient biomass conversion to bioethanol and biodiesel.

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